considerably improved in their powers of resistance to a transverse strain.

8. "On extraordinary Oscillations of the Sea; with an account of some Observations in Mount's Bay." By Richard Edmonds, Jun. Communicated by Sir Charles Lemon, Bart., F.R.S.

In this communication the author notices many remarkable oscillations of the sea which had been observed nearly a century ago in Mount's Bay and Plymouth Sound, and also elsewhere. He then particularly describes some which have occurred more recently at the former places. Of these the following are the principal:—

On the morning of the 31st of May, 1811, the sea was observed to rise and fall rapidly from 4 to 8 feet.

On the 5th of July, 1843, the author witnessed oscillations of the sea in Mount's Bay.

In the evening of the 30th of October, 1843, oscillations of the sea were observed in Mount's Bay and at Plymouth.

On the morning of the 5th of July, 1846, immediately after a terrific thunder-storm, oscillations of the sea were observed at Marazion. The author remarks that the great storm which passed over England on this day raged in the Atlantic during the night of the 4th of July.

On the morning of the 1st of August, 1846, the sea at Penzance pier was observed suddenly to rise between 1 and 2 feet, and as suddenly to rush back. It is remarked that London and its vicinity were visited on this day by a most destructive hail- and thunder-storm.

On the 23rd of May, 1847, there were extraordinary oscillations of the sea, and a slight motion of the ground was felt on the cliff between Newlyn and Mousehole.

After referring to the theories which have been advanced in explanation of these phenomena, the author observes, in conclusion, that, from what he has stated on the subject, and from the fact of earthquakes, as well as extraordinary oscillations of the sea, having so frequently occurred during thunder-storms, he sees no difficulty in the supposition, that all the oscillations to which he has referred may have resulted from submarine shocks of the earth, occasioned by electrical discharges between the earth and the atmosphere, or between oppositely electrified portions of the earth.

June 20, 1850.

THE EARL OF ROSSE, President, in the Chair.

The following papers were read:—

1. "Observations on the Nebulæ." By the Earl of Rosse, Pres. R.S., &c. &c.

The object of this paper is to lay before the Royal Society an account of the progress which has been made, up to the present time,

in the re-examination of Sir John Herschel's Catalogue of Nebulæ published in the Phil. Trans. for 1833.

Before describing any of the interesting objects the peculiar features of which the extraordinary powers of the telescope employed for their examination has brought to our knowledge, the author enters upon some details concerning the instrument itself. This telescope, which for aperture and the consequent power it possesses for the examination of faint details must for a considerable time, at least, remain unrivalled, has a clear aperture of 6 feet, with a focal length of 53 feet. It has hitherto been used as a Newtonian, but by the easy application of a little additional apparatus it may be conveniently worked as a Herschelian; and the author thinks it not improbable that, in the further examination of the objects of most promise with the full light of the speculum *undiminished by a second reflexion*, some additional features of interest will come out.

The tube reposes at its lower end upon a very massive universal joint of cast iron, resting upon a pier of stonework buried in the ground, and it is counterpoised so that it can be moved in polar distance with great facility. The extreme range of the tube in right ascension at the equator is one hour, but greater as the polar distance diminishes. By a little subsidiary apparatus the movement of the telescope can be rendered almost exactly equatorial; but up to the present time this apparatus has not been used, as, without it, the movement was found to be sufficiently equatorial for such measurements as have been required. The whole mounting was planned especially with a view of carrying on a regular system of sweeping; but as yet the discovery of new nebulæ has formed no part of the systematic work of the observatory, the known objects which require examination being so numerous that hitherto the observers have been fully occupied with them.

A clock movement was part of the original design, but as yet the telescope is not provided with one, and the want of it has not been very much felt.

Various micrometers have been tried, but, upon the whole, the common wire micrometer with thick lines has been found to succeed the best; for the faint details of the nebulæ are extinguished by any micrometrical contrivance which either diminishes the light of the telescope or renders the field less dark; and thick lines have been found to be visible without illumination in the darkest night.

The telescope has two specula, one about three and a half, and the other rather more than four tons weight. Each is provided with a system of levers to afford it an equable support. Upon this system it was placed before it was ground, and has rested upon it ever since. The systems of levers with the mode of applying them in the support of the speculum are described in the paper, and also the precautions taken to guard against strain and consequent flexure of the metal. Notwithstanding these precautions, undoubted evidences of flexure in the speculum have occasionally shown themselves. It has not, however, been found that flexure, even to the extent of materially disfiguring the image of a large star, interferes

much with the action of the speculum on the faint details of nebulæ, although it greatly lessens its power in bringing out minute points of light, and in showing resolvability where, under favourable circumstances, resolution had been previously effected.

It is stated that, in the spring of 1848, the heavier of the two specula, for nearly three months, performed admirably, very rarely exhibiting the slightest indication of flexure. It then remained inactive for some time before and after the solstice, and when observations with it were again commenced, it was found to be in a state of strain. On cautiously raising it a little by screws, for the purpose of readjusting the levers, it was found that the unequal strain of the screws had produced permanent flexure, so that the speculum did not again perform well until after it had been reground. Recently an alteration has been made in the mode of supporting the lighter of the two specula, which now rolls freely on eighty-one brass balls that support it nearly equably. After referring to other causes of unequal action, among which the varying state of the atmosphere is one of the most serious, the author remarks that the Society will not be surprised should it be in his power at a future time to communicate some additional particulars, even as to the nebulæ which have been most frequently observed.

The very beautiful sketches which illustrate the paper, are, it is remarked, on a very small scale, but are sufficient to convey a pretty accurate idea of the peculiarities of structure which have gradually become known. In many of the nebulæ they are very remarkable, and seem even to indicate the presence of dynamical laws we may perhaps fancy to be almost within our grasp.

On examining these sketches, it will at once be remarked, as stated by the author, that the spiral arrangement so strongly developed in H. 1622, 51 Messier, is traceable more or less distinctly in several of the sketches. More frequently indeed there is a nearer approach to a kind of irregular interrupted annular disposition of the luminous material, than to the regularity so striking in 51 Messier; but it can scarcely be doubted that these nebulæ are systems of a very similar nature, seen more or less perfectly, and variously placed with reference to the line of sight. The author adverts to the description of this nebula by Messier, Sir William Herschel and Sir John Herschel, and remarks, that taking the figure given by Sir John, and placing it as it would be seen with a Newtonian telescope, we shall at once recognise the bright convolutions of the spiral which were seen by him as a divided ring: thus with each increase of optical power the structure has become more complicated, and more unlike anything which we could picture to ourselves as the result of any form of dynamical law of which we find a counterpart in our system. After pointing out the importance of measurements and the difficulty of taking them satisfactorily, the author states, that of a few of the stars with which the nebula is pretty well studded, measurements with reference to the principal nucleus were taken by his assistant Mr. Stoney in the spring of 1849, and that these have been repeated this year during the months of April and May, and also some mea-

sures taken from the centre of the principal nucleus to the apparent boundary of the spiral coils in different angles of position. A hope is then expressed that, as several of these stars are no doubt within reach of the great instruments at Pulkova and at Cambridge, U.S., the distinguished astronomers who have charge of them will consider the subject worthy of their attention.

The spiral arrangement of 51 Messier was detected in the spring of 1845, and in the following spring an arrangement, also spiral, but of a different character, was detected in 99 Messier. The author considers that 3239 and 2370 of Herschel's 'Southern Catalogue' are very probably objects of a similar character; and as the same instrument does not appear to have revealed any trace of the form of 99 Messier, he does not doubt that they are much more conspicuous, and therefore entertains the hope that, whenever the southern hemisphere shall be re-examined with instruments of great power, these two remarkable nebulæ will yield some interesting result.

The author briefly refers to the other spiral nebulæ discovered up to the present time, which are more difficult to be seen, and to clusters in the exterior stars of which there appears to be a tendency to an arrangement in curved branches. He then passes to the regular cumular nebulæ, in which, although they are perceived at once to be objects of a very different character, there still seems to be something like a connecting link.

Among the nebulous stars two objects are stated to be well worthy of especial notice—No. 450 of Sir John Herschel's Catalogue, and *i* Orionis. A representation of No. 450, as seen with the six-feet telescope, is given. It has been several times examined, but as yet not the slightest indication of resolvability has been seen. The annular form of this object was detected by Mr. Stoney when observing alone, but Lord Rosse has since had ample opportunities of satisfying himself that the object has been accurately represented. A representation of *i* Orionis is likewise given. The remarkable feature in this object, the dark cavity not symmetrical with the star, was also discovered by Mr. Stoney when observing alone with the three-feet telescope. Lord Rosse has since seen it several times and sketched it. A small double star *n.f. i* has similar openings, but are not so easily seen. These openings appear to be of the same character as the opening within the bright stars of the trapezium of Orion, the stars being at the edges of the opening. Had the stars been situated altogether within the openings, the suspicion that the nebula had been absorbed by the stars would perhaps have suggested itself more strongly. As it is, the author thinks we can hardly fail to conclude that the nebula is in some way connected with these bright stars, in fact that they are equidistant, and therefore, if the inquiries concerning parallax should result in giving us the distances of these bright stars, we shall have the distance of this nebula.

The long elliptic or lenticular nebulæ are stated to be very numerous, and three sketches of remarkable objects of this class are given.

In proceeding with the re-examination of Sir John Herschel's

Catalogue, several groups of nebulæ have been discovered, in some of which nebulous connexion has been detected between individuals of the group, in others not. Sketches of some have been made and measures taken; but although the subject of grouped or knotted nebulæ is considered one of deep interest, it has not yet been proceeded with far enough to warrant entering upon it in the present paper.

The conclusion of the paper is occupied with remarks relating to each figure, in order to render the information conveyed by it more complete, and these are stated to be for the most part extracts selected from the Journal of Observations.

2. "Electro-Physiological Researches.—Ninth Series." By Signor Carlo Matteucci. Communicated by W. R. Grove, Esq., F.R.S.

In the first portion of this paper the author refers to a work recently published by M. Du Bois Raymond "On the law of Muscular Current, and on the modification which that law undergoes by the effect of Contraction;" which work M. Matteucci states obliges him to transmit to the Royal Society certain researches the publication of which he would otherwise have wished to delay. He then refers to his previous researches published in the Philosophical Transactions for the years 1845 and 1847, and in the Annales de Chimie for October 1847. From the experiments detailed in those papers, and from certain points of doubt which he indicates, he considers himself authorized in concluding that the development of electricity by muscular contraction still remains to be demonstrated by experiment, and that the phenomenon of induced contraction is still that which leads most directly to this result.

He then gives a series of experiments illustrated by figures, and from them deduces the following conclusions:—

1st. The cause of induced contraction, according to all analogies, is the same as that which produces contraction of the galvanoscopic frog in several of the experiments given.

2ndly. The cause of these contractions is evidently an electrical phenomenon developed in the act of contraction, and which consists in a different state of electricity in the different points of the contracted limb.

3rdly. This electrical phenomenon, like the contraction which produces it, lasts only for an instant.

4thly. These electric states, developed by contraction, tend to produce electrical currents which circulate in opposite directions across a conducting arch interposed between the two limbs, which contract at the same time.

The author further states, that, whatever the theory of these phenomena may be, it is certain that they demonstrate the production of an electrical *disequilibrium* in the act of muscular contraction. Upon the question whether the cause of the species of discharge described is a phenomenon analogous to that of electrical fish, or a change in the natural conditions of the muscular current, the author, though leaning to the former alternative, forbears to express a posi-